CLAIMS

1) A frequency stabilisation apparatus for stabilising a frequency output of a laser cavity, the frequency stabilisation apparatus comprising an intracavity birefringent etalon, wherein the intracavity birefringent etalon is employed to derive a polarised electric field component from an intracavity electric field of the laser cavity, the orientation of polarisation of the polarised electric field component being dependent on the frequency and polarisation of the intracavity electric field.

2) A frequency stabilisation apparatus as claimed in Claim 1 wherein the intracavity birefringent etalon acts as a first quarter waveplate on the polarised electric field component such that when the frequency of the intracavity electric field corresponds to a resonant frequency of the birefringent etalon the polarised electric field component is linearly polarised.

3) A frequency stabilisation apparatus as claimed in Claim 1 or Claim 2 wherein the frequency stabilisation apparatus further comprises a second quarter waveplate.

4) A frequency stabilisation apparatus as claimed in Claim 3 wherein the frequency stabilisation apparatus further comprises an elliptical polarisation analyser for analysing the state of polarisation of the polarised electric field component on being transmitted through the second quarter waveplate.

5) A frequency stabilisation apparatus as claimed in Claim 4 or Claim 5 wherein an optical axis of the second quarter waveplate is aligned with an optical axis of the birefringent etalon such that on being transmitted through the second quarter waveplate the polarised electric field component is linearly polarised, the plane of linear polarisation being dependent on the frequency of the intracavity electric field relative to the resonant frequency of the birefringent etalon.

6) A frequency stabilisation apparatus as claimed in Claim 4 or Claim 5 wherein an optical axis of the second quarter waveplate is aligned at 45° relative to an optical axis of the birefringent etalon such that on being transmitted through the second quarter waveplate the polarised electric field component of an off resonance frequency is linearly polarised, the plane of linear polarisation being dependent on the frequency of the intracavity electric field relative to the resonant frequency of the birefringent etalon.

7) A frequency stabilisation apparatus as claimed in any of Claims 4 to 6 wherein the elliptical polarisation analyser comprises a polarisation dependent beamsplitter and two light detecting means wherein the polarisation dependent beamsplitter is orientated so as to resolve the polarised electric field component into two spatially separated components each of which is incident on one of the light detecting means.

8) A frequency stabilisation apparatus as claimed in Claim 7 wherein the elliptical polarisation analyser further comprises an electronic circuit wherein the electronic circuit derives an error signal from electrical output signals generated by the two light detecting means.

9) A frequency stabilisation apparatus as claimed in Claim 8 wherein the electronic circuit further comprises a feedback circuit for generating a feedback signal in response to the error signal so as to control the orientation of the birefringent etalon within the intracavity electric field in order to minimise the magnitude of the error signal.

10) A frequency scanning apparatus for scanning a frequency output of a laser cavity comprising a frequency stabilising apparatus as claimed in any of Claims 1 to 9 and a cavity length adjuster that provides a means for scanning a length of the laser cavity.

11) A frequency scanning apparatus as claimed in Claim 10 wherein the cavity length adjuster comprises at least one laser cavity mirror mounted on a piezoelectric crystal.

12) A method for stabilising a frequency output of a laser cavity comprising the steps of:

1) Employing a birefringent etalon to sample an intracavity electric field of the laser cavity so as to derive a polarised electric field component whose polarisation is dependent on the polarisation

and frequency of the intracavity electric field relative to a resonant frequency of the birefringent etalon;

2) Deriving an error signal from the polarised field component; and

3) Stabilising the birefringent etalon to the derived error signal.

13) A method as claimed in Claim 12 wherein the polarised electric field component is linearly polarised when the intracavity electric field corresponds to a resonant frequency of the birefringent etalon.

14) A method as claimed in Claim 12 or Claim 13 wherein the polarised electric field component is elliptically polarised when the intracavity electric field corresponds to a non-resonant frequency of the birefringent etalon.

15) A method as claimed in Claim 14 wherein the helicity of the polarised electric field component is of an alternative sign when the intracavity electric field frequency is above or below the resonant frequency of the birefringent etalon.

16) A method as claimed in any of Claims 12 to 15 wherein the step of deriving the error signal comprises the steps of:

1) Introducing a $\pi/2$ phase shift to the orthogonal constituent components of the polarised electric field component;

2) Resolving the orthogonal constituent components of the polarised electric field component; and

3) Calculating an intensity ratio signal the orthogonal constituent components of the polarised electric field component.

17) A method as claimed in Claim 16 wherein the step of introducing the $\pi/2$ phase shift to the orthogonal constituent components of the polarised electric field component results in the plane of polarisation of the polarised electric field component being directly dependent on the frequency of the intracavity electric field relative to the resonant frequency of the birefringent etalon.

18) A method as claimed in any of claims 12 to 17 wherein the birefringent etalon is stabilised to the derived error signal by controlling the orientation of the birefringent etalon within the intracavity electric field in order to minimise the magnitude of the error signal.

19) A method for scanning a frequency output of a laser cavity comprising:

1) Stabilising the frequency output of the laser cavity in accordance with the method of any of Claims 12 to 18;
2) Scanning an optical length of the laser cavity; and
3) Scanning the orientation of the birefringent etalon within the intracavity electric field in order to track the scanned optical length of the laser cavity.